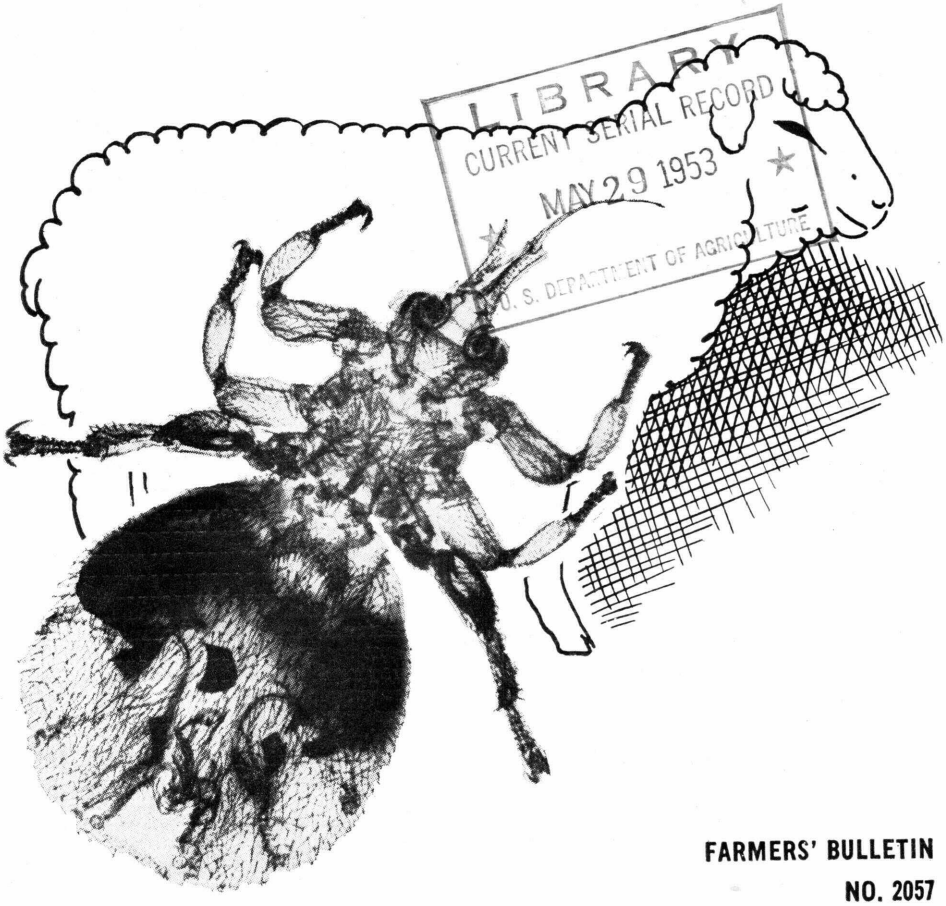
# the Sheep tick and Its Eradication




FARMERS' BULLETIN
NO. 2057

UNITED STATES DEPARTMENT OF AGRICULTURE

THE SHEEP TICK, although not a true tick, is a bloodsucking parasite which infests sheep on both farms and ranges. It is widely prevalent and spreads rapidly, especially among close-herded range flocks, where it may cause much damage and loss. The nature and habits of the tick are described, also methods of identifying it.

The sheep tick can be eradicated in one treatment by either dipping or spraying with rotenone or with the chlorinated hydrocarbon insecticides in common use. When other dips are used, two dippings are necessary, about 24 days apart, as the first dipping may not destroy all the pupae, sometimes erroneously called eggs, and from these a new brood may result.

Methods of dipping large and small flocks are discussed, and plans of a concrete vat, showing details of construction, are given.

## CONTENTS



WASHINGTON, D. C. Issued February 1953

COVER ILLUSTRATION: Sheep tick (ked), Melophagus ovinus.

# The Sheep Tick and Its Eradication[1]

H. E. KEMPER, *Veterinarian*, and H. O. PETERSON, *Parasitologist*
*Zoological Division, Bureau of Animal Industry*
*Agricultural Research Administration*

## Distribution and Economic Importance

THE SHEEP TICK (*Melophagus ovinus*) is not a true tick but a wingless parasitic fly which passes the various stages of its life cycle on sheep. In many of the English-speaking countries it is known as the "ked" or the "louse fly" from its habit of living in the wool like a louse. Among the sheep growers of this country it is commonly known as the sheep tick. It is widely distributed in many of the sheep-growing countries of the world, including the United States; there it occurs in all the States where sheep are kept. It is most prevalent, however, in the western range States where sheep are herded in large flocks.

Many of the farm flocks of the United States harbor sheep ticks in sufficient numbers to cause considerable damage, especially on farms where open-fleece sheep are kept.

The sheep tick obtains its food by puncturing the skin with its lancelike proboscis, or sucking tube, and feeding on blood and lymph. The quantity of blood consumed by one tick in 24 hours is small; the total amount taken by a large number of ticks is considerable. The irritation is very great, especially in heavily infested lambs. The sheep become restless and bite and rub themselves, breaking up the wool and lowering its quality. They do not feed well, and consequently do not grow and fatten rapidly. Infested flocks suffer losses from shrinkage in weight and from general unthriftiness. Their vitality and resistance to diseases is reduced. Tick infestations not only reduce the market value of sheep, but also tend to reduce wool growth. Being a bloodsucker, the tick does not feed on the yolk of the wool or directly injure the fibers to any great extent. However, tick debris and fragmented pupal cases discolor the wool and may lower its market value.

## Life History

A true tick in the adult stage has eight legs, but the sheep tick (a fly) has only six legs and in general form and structure is entirely different (fig. 1). Like other insects, sheep ticks vary in size, but the average length of adult females is about one-quarter of an inch. The life cycle of the sheep tick is divided into four natural stages, namely, the egg, the larva, the pupa, and the adult or sexually mature insect.

The egg is not laid, but is retained in the body of the female, where it develops into a larva in about 7 days. At birth the larva is covered with a soft white membrane, which turns brown and becomes a hard shell, called a puparium, in about 12 hours (fig. 2, *A*). The term "pupa" applies to that stage in the life of the sheep tick from the time the pupa is deposited until the young tick emerges. During this stage the pupa remains within its hard shell, which is attached to the wool fibers by a gluelike substance which dissolves readily in water.

[1] This bulletin is a revision of and supersedes Farmers' Bulletin 798, The Sheep Tick and Its Eradication by Dipping.

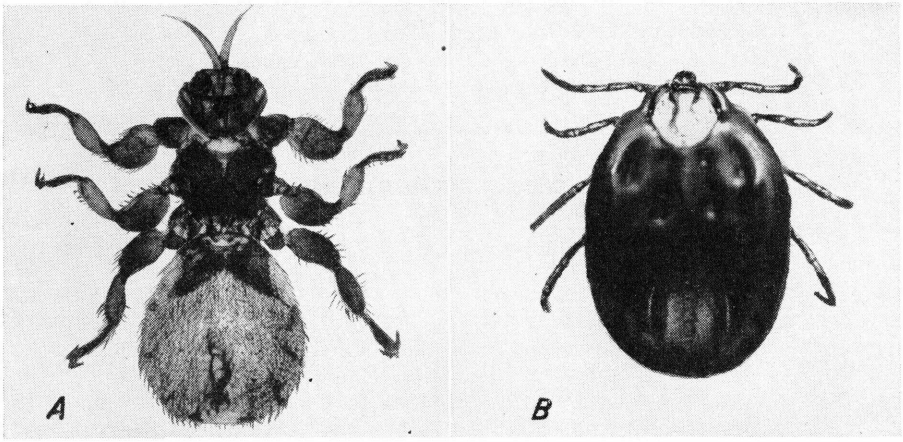



Figure 1.—Comparison of form and structure of sheep tick and true tick: A, sheep tick (engorged female, enlarged); B, true tick (engorged female, enlarged).

These shell-covered pupae are commonly called eggs. In 19 to 24 days from the time it is deposited the shell of the pupa is broken open at one end and the young tick emerges and becomes active in the fleece.

The time between the depositing of the pupa and the emergence of the young tick is called the period of incubation, and its duration is influenced by temperature. During warm weather the average period of incubation is about 19 days; during cold weather it is about 24 days, or longer. However, in practical operations under average conditions, 24 days has been assumed to be the longest period.

At the time the young tick emerges from the shell it is almost as large as a full-grown tick (fig. 2, *B* and *C*). It develops very rapidly and reaches sexual maturity in 3 or 4 days. The female deposits her first pupa within 8 to 10 days after being fertilized.

The life history of the sheep tick, from the practical standpoint, may be summarized thus: Counting from the time when it emerges from the shell, the young tick deposits its first pupa or so-called egg in about 14 days. From this pupa a young tick emerges within 19 to 24 days. These two stages in the life history have an important bearing on the problem of eradication.

Dipping, spraying, or dusting, if properly done with insecticides containing derris or cube powder of 5-percent rotenone content, or DDT, BHC, lindane, or toxaphene can usually be depended upon to eradicate sheep ticks in one treatment. These insecticides kill the adult ticks, and remain in the wool sufficiently long to destroy all young ticks as they hatch. Other kinds of insecticides, such as nicotine, coal tar, creosote, and cresol, usually destroy all the adult ticks, but cannot be depended upon to destroy new-hatched ticks because they lack the residual toxic action of the aforementioned substances. With these insecticides, therefore, the pupae that remain alive in the wool after the first treatment will produce a new generation of ticks.

This new generation must be destroyed by a second treatment before they have had time to develop and deposit pupae. On the other hand, the second treatment should not take place before all the pupae in the wool at the time of the first treatment have had time to mature. Otherwise they may emerge after the second treatment and reinfest the flock. Consequently, it is im-

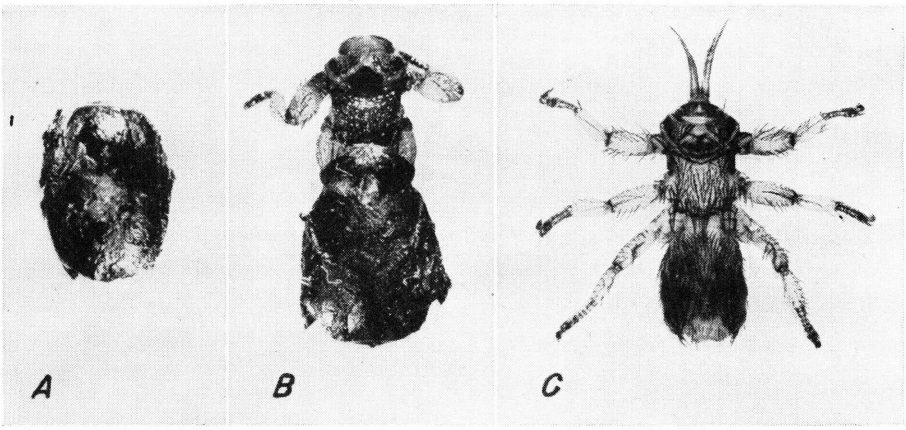



Figure 2.—A, Pupa of sheep tick, commonly called the egg, taken from the fleece of sheep; B, young sheep tick emerging from the puparium; C, young sheep tick just after emerging from the puparium. Enlarged.

portant to allow a proper interval between the first and second treatments if the results are to be successful. The first treatment probably destroys many of the pupae that are less than 4 days old, and the insecticide remaining in the wool has a tendency to prevent the development of young ticks and probably kills many of them. Under average conditions during early fall treatment, 24 days should elapse between the first and the second treatments.

## Nature and Habits

True ticks, such as the cattle-fever ticks, do not pass their entire lives on the animal, but always drop to the ground to lay their eggs. The life history of the sheep tick (fig. 3) is more simple. It does not drop off the sheep to lay eggs, but deposits its pupae in the fleece. Each female deposits an average of from 12 to 15 pupae during her lifetime, 1 being laid about every 7 or 8 days. The pupae are attached to the wool fibers, usually from one-half inch to an inch from the skin. Consequently when the sheep are shorn the majority of them are removed with the fleece.

Sheep ticks bury their sucking tubes in the skin to feed; when not feeding they move about in the fleece. During cold, inclement weather they remain deep in the fleece close to the skin for shelter and warmth, but when the days are warm they move nearer the surface and often can be seen in great numbers crawling over the tips of the wool. At times they are dislodged and temporarily infest trails, pastures, corrals, bed grounds and premises. They crawl upon another sheep at the first opportunity.

The sheep tick does not transmit any known disease to sheep.

When the flock is heavily infested, ticks may be found on any part of the body, but they usually select locations where the wool is thin or where they are best protected from the efforts of the sheep to dislodge them. The neck, breast, shoulders, belly, and thighs are favorite locations.

The tick population on sheep fluctuates between rather wide limits throughout the year. The ticks and pupae on animals were counted before and after shearing, and approximately 50 percent of the ticks and 95 percent of the pupae were removed with the fleece. Freshly

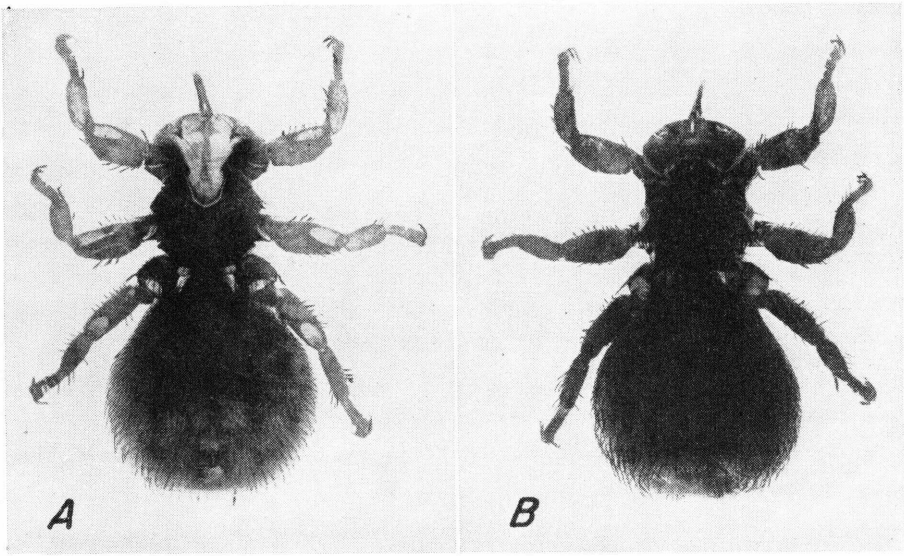



Figure 3.—A, Mature male sheep tick, ventral view; B, mature male sheep tick, dorsal view. Enlarged.

shorn sheep offer very little protection for ticks, as the ticks are exposed to weather and some become dislodged as the animal grazes. Many of the ticks migrate from freshly shorn adults to lambs, where the environment is more favorable. The tick population continues to decrease on sheared sheep and reaches its lowest level in the early fall months. Thereafter, it begins a rapid increase through the late fall, winter, and spring months and reaches its highest numbers at about the time of shearing. The lambs suffer most from this pest and, if they become heavily infested, receive a setback at an important period in their development, thus causing considerable financial loss.

## Spread

When sheep ticks are introduced into a flock, they spread rapidly until the entire flock is infested. On the range where sheep are closely herded, or wherever they are crowded into corrals, and come into close contact on the bed grounds, the ticks pass readily from one animal to another. On farms where sheep are not closely herded, but graze in fenced inclosures, the conditions are not so favorable for rapid spreading. During cold weather, however, when sheep are placed in corrals, sheds, or barns, in close contact, every member of the flock becomes infested if there are ticks on any of them.

Sheep ticks will not propagate or live for any considerable time on animals other than sheep or goats, although they may be harbored temporarily by dogs or other animals that come in close contact with an infested herd. Men working among infested sheep may carry the parasites on their clothing and thus be the means of introducing them into clean flocks. If separated from sheep the ticks do not live longer than about 4 days as a rule, and it might be assumed that places from which all sheep have been removed would become free from ticks within a very few days. However, the survival of dislodged ticks is not the only factor influencing the length of time premises may

remain infested after the removal of infested sheep. Tags of wool to which pupae are attached may be pulled out by bushes, fences, etc., or by the sheep themselves. If the weather is warm and other conditions favorable, these pupae will emerge as ticks and infest the premises.

Under ordinary conditions the period of incubation is from 19 to 24 days or longer, the length of the period being influenced by temperature and other factors. Laboratory experiments have indicated that the incubation period of pupae removed from sheep may be as long as 46 days. Infested sheep, in their efforts to obtain relief from the irritation and itching, may dislodge some of the ticks and pupae. The ticks will die in a few days, but if conditions are favorable, the pupae will retain their vitality and emerge as ticks in due time. The pupae dislodged from sheep during cold weather or when the nights are frosty will be destroyed. It seems reasonably certain that freezing temperatures will destroy the vitality of the pupae.

These facts have an important bearing on the problem of eradication. Premises that have become infested from ticky sheep may, under favorable conditions, remain infested for 45 to 50 days after the sheep are removed. During warm weather, consider all premises occupied by ticky sheep as infested for 60 days from the date of infestation. During cold weather, when the temperature drops to freezing at any period during the day or night, premises probably would become free from infestation within a day or two, except in places well protected from the cold, such as sheds or stables.

During warm weather do not keep clean sheep in infested corrals or enclosures. If it is necessary to use such corrals, remove all litter and manure, clean down to a smooth surface, and then spray the floors and sides with a good disinfectant. Cleaning should be done carefully in order that all pupae may be removed with the litter, as the disinfectant probably will not destroy the vitality of the pupae. All litter and manure from infested premises should be plowed under or disposed of in such manner that sheep cannot come in contact with it for at least 60 days.

An economical and effective method of disinfecting corrals enclosed with stone or wire fences is to scatter straw or brush over the surface of the ground and burn it. If the brush or straw is dry, it will burn readily and produce sufficient heat to destroy the parasites.

## Detecting Ticks in Flock

When sheep are heavily infested with ticks they bite and scratch and rub against any available object, including other members of the flock. The natural position of the wool is disturbed by their efforts to obtain relief from the intense itching; some wool is pulled out, and the fleece may have a ragged appearance (fig. 4).

Sheep ticks may be found by parting the wool over the neck, breast, shoulders, belly, and thighs. They are large enough to be seen readily and are of a brownish color. On warm days they often may be observed crawling over the tips of the wool. If ticks are present pupae usually will be found attached to the wool fibers. These are seen easily with the naked eye, being about one-eighth inch in length. Their color varies from yellowish white to dark brown, and the shell is glossy and firm (fig. 5).

Not all conditions which cause sheep to bite and scratch themselves are caused by ticks. In every instance close examination should be made to determine the cause. Of course, the presence of ticks does

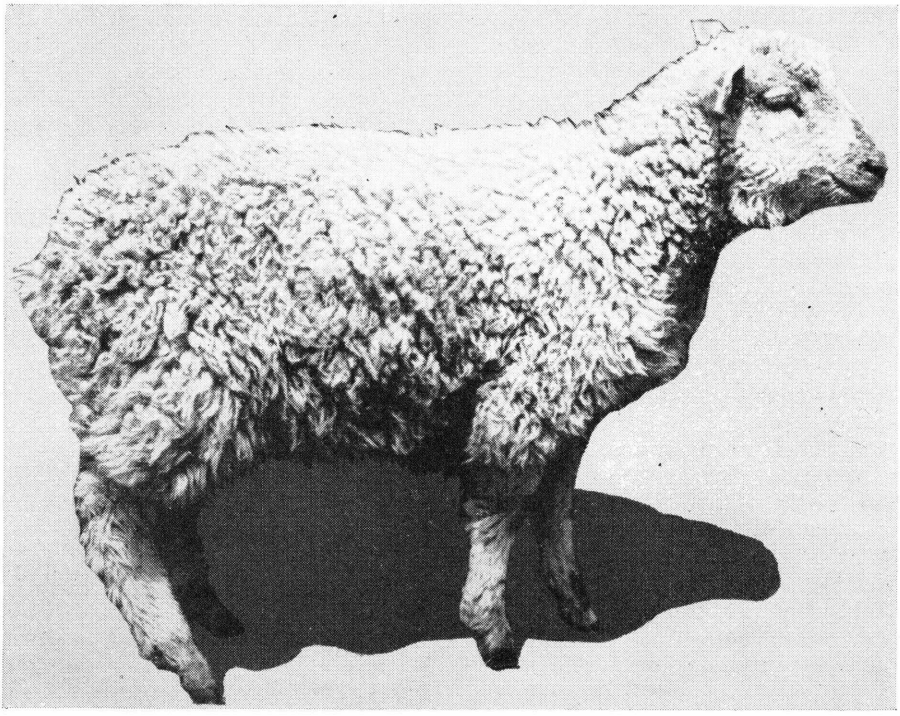


Figure 4.—Lamb grossly infested with sheep ticks, showing roughened condition of fleece.

not exclude other possible causes of irritation, such as scab, lice, common ticks, bearded seeds, thorns, etc.

## Treatment By Dipping

Dipping consists of immersing animals in a medicated liquid that will kill the ticks, and is the most practicable method known for eradicating sheep ticks. It is necessary that the medicated liquid come in direct contact with the parasite. Very few of the known dips will kill ticks immediately. Therefore, sheep must be held in the dip long enough to saturate the fleece. The length of the wool, the quantity of dip retained in the fleece, the length of time the dip remains active in the wool, and the nature of the active principle, all have an important bearing on the results. Other factors being equal, the dip that remains longest in the wool and retains its killing power for the longest period is most desirable, not only for destroying the parasites but also for preventing reinfestation.

When dipping sheep for ticks the entire flock, together with goats, dogs, and other animals associated with the sheep, should be dipped regardless of the number showing infestation, as one untreated animal can reinfest the entire flock. The fleece should be saturated thoroughly, but as there are no crusts or scabs to be penetrated, it is not necessary to hold the animals in the vat longer than about 1 minute. The head of each animal should be submerged at least once and care taken that every part of the fleece is wet. The dip should not be cold enough to chill the animals; the temperature should be between a minimum of 65° F. and a maximum of 80° F., ascertained

Figure 5.—Close view of portion of neck of lamb shown in figure 4, showing ticks and pupae in wool.

accurately with a thermometer. If a proprietary dip is used, the instructions on the container should be followed closely.

The season best suited for dipping to eradicate ticks depends upon the altitude, the climatic conditions, and the methods of handling the sheep. The most opportune time is shortly after shearing, as soon as shear cuts have healed. The weather is usually warm at shearing time, the tick population has been reduced in the shearing process, and less of the insecticide is required when the wool is short. Lambs too young to be dipped in the ordinary vat may be hand-dipped in a barrel or tub. Adult animals should be dipped in a regular vat at the same time. All flocks in a given neighborhood should be dipped at about the same time in order to lessen the chances of reinfestation.

## Important Precautions

For dipping to be successful, pay close attention to details and see that the work is performed carefully and thoroughly. Do not dip sheep immediately after shearing; a period of at least 10 days should elapse between shearing and dipping so that all cuts may be healed. It is dangerous to dip sheep having fresh wounds, as some of the dips cause a condition commonly known as "blood poisoning." The mortal-

239470°—53——2

ity from this condition is high. Do not allow dogs that bite in the dipping corrals. Examine the chutes, pens, and dipping vat closely for nails, broken boards, or any object that may puncture or wound the skin of the sheep. After the wounds have granulated or healing is well started there is little or no danger of poisoning from dipping. Rough handling causes more damage to sheep than is caused by the dip. The men placing the sheep in the dipping vat should be instructed to do so carefully. They should not be allowed to catch the sheep by the ears; this results in breaking or bruising the skin, which causes the heads to swell and results in considerable death loss.

Ewes and lambs should not be dipped together. The danger of drowning some of the lambs is much greater than when they are dipped separately. The lambs should be "cut out" and dipped separately, and need not be held in the swim as long as the older sheep. It has been stated that the ewe recognizes her lamb more readily when they are dipped together; this, however, is probably not correct. A ewe recognizes her lamb by smell and not by sight; consequently after the flock has been dipped and the ewes and lambs have been turned in together there is considerable commotion for a time, as the ewes fail temporarily to recognize their offspring. However, the members of the flock will adjust matters themselves and, as a rule, practically every lamb will be recognized by its mother. It often happens that an undipped sheep will jump out of the pens and get in with those that have been dipped. This should be carefully guarded against and all such sheep dipped.

Sheep should not be thirsty or hungry at the time of dipping, nor too full of feed and water. If watered and fed 3 to 6 hours before being dipped they are likely to be in the best condition. When the weather is cold or stormy, start dipping operations early in the morning and be finished for the day by noon, so that the flock may have time to dry off and fill up with feed before night. A sheep with a full stomach can withstand much cold and hardship. If these precautions are observed sheep may be dipped with reasonable safety during cold weather.

Bucks should be dipped separately from ewes and lambs. They should not be driven fast and then put into the vat before resting and cooling off. They succumb very easily in the vat, and it is necessary to give them careful attention. At the large vats the buck herds usually are dipped first, while the vat is full, so as to afford them more swimming room.

Isolate and treat individually all sick and injured animals.

## Directions for Dipping

The quantity of dip should be sufficient to submerge the sheep completely. The depth of the dipping fluid in the vat should be not less than 40 to 48 inches, depending on the size of the sheep. Ascertain the quantity of fluid necessary to fill the vat to the required depth before starting to prepare it. Freshly shorn sheep and short-wool lambs will carry out an average of from 1 to 2 quarts of dip, depending on the size of the sheep and the length and grade of wool. When in full fleece, fine-wool sheep will carry out and retain as much as 2 gallons. During the late fall, the average medium-wool sheep will retain in the fleece about 1 gallon of dip. In estimating the quantity of dip required, these facts should be taken into consideration. After computing the quantity of dip required to charge the vat, estimate the average quantity each sheep will carry out. Multiply this by

the number of sheep to be dipped and add the product to the quantity required to fill the vat. If the vat and draining pens are water-tight and no dip is lost, the total will be approximately the number of gallons required to complete the work.

After the vat is filled to the required depth, stir the contents thoroughly. If the dip requires heating, stirring creates a uniform temperature throughout. If wettable powders are used, they tend to sink to the bottom, and it is necessary to stir them to produce a uniform suspension of the powder. The contents can be stirred with a bucket on the end of a rope. Allow the bucket to fill with water and sink to the bottom. Then drag it back and forth the length of the vat. Continue stirring until the temperature is uniform throughout the vat; take the temperature at several points. Stirring plungers (fig. 6, A) are useful implements, and one or more should be provided at every vat. They are plunged up and down like the dasher of an old-fashioned hand churn, the process being repeated as the operator moves slowly along the vat.

Change the dip as soon as it becomes filthy, regardless of the number of sheep that have been dipped in it. Remove the entire contents, including all sediment and foreign matter. After draining off the liquid portion, sweep or scrape the sediment and dirt from the bottom with a hoe or spade. Dip in which sheep have been treated should not be used again after it has stood in the vat 10 days or more.

Dips deteriorate through use. After a number of sheep have passed through the vat the active principle of the dip falls below the standard required for effective work. Before approving a dip for use in official dipping, the Bureau of Animal Industry requires that there shall be a practical field test for such dip, so that the strength of the dip in the vat can be ascertained at any time.

Drowning of sheep can be avoided by proper care. Men with

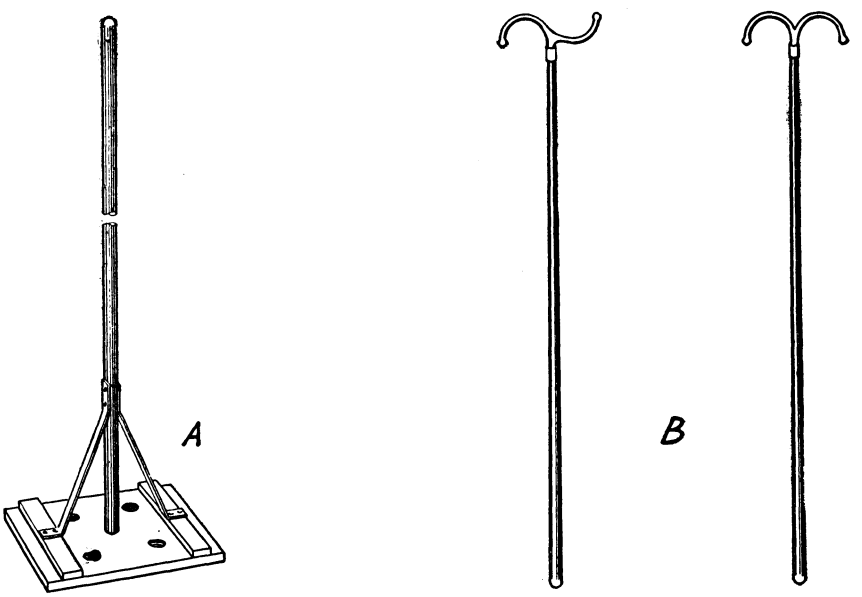



Figure 6.—A. Stirring plunger of the style most commonly used for mixing liquids in the vat. B. Two styles of dipping forks.

dipping forks should be stationed along both sides of the vat to attend the sheep and prevent accidents. When the vat becomes filled with sheep their progress is retarded and they frequently attempt to raise themselves out of the dip by placing their forefeet on the back of another. The men along the vat should prevent this by keeping the sheep properly arranged in the vat.

Dipping forks are used to keep the sheep submerged, except its head. The dipping fork is placed over the shoulders of the sheep, which is pushed under gently but firmly. The animal will raise its nose so that the neck and part of the head can be submerged without danger of strangling. The head should be pushed under for a moment twice while the animal is going through the vat. Old ewes that have been dipped a number of times are sometimes difficult to handle, both in the chutes and in the dip. They will often lie on their sides in the vat, bracing themselves with their feet against one side and their backs against the other. When pushed under they may make efforts to regain this position and may strangle.

Sheep that have eaten loco weed often drown in the vat unless they are piloted through. When a sheep strangles, take it from the vat. If it does not get to its feet, pull its tongue forward, dash cold water over its head and body, and, if necessary, induce artificial respiration. When it has regained sufficient strength, and if it has not been in the dip long enough, return it to the pens and pilot it through again.

### Dipping Forks

At large vats dipping forks are necessary for the efficient handling of the sheep. Several different styles are made. The two shown in figure 6, *B* are the ones commonly used. The one with both hooks turned upward is preferred because either side may be hooked under the neck of the sheep to raise the head in case of strangling. The handles should be strong and from 5 to 6 feet long. The hooks should be made of half-inch round iron with blunt ends and firmly held in the handle by an iron ferrule. These forks can be bought ready-made or may be made by a blacksmith.

### Water for Dipping Purposes

Sheep dips are most effective when made with soft water. If alkaline water is used, it can be softened by using sal soda in the proportion of 1 to 4 pounds for each 100 gallons of water, depending upon its "hardness." If the water is very impure it should be analyzed and advice of a competent chemist obtained on methods of rendering it suitable for insecticidal purposes. All insecticides, if used in unsuitable water, or in concentrations too high, may injure the sheep.

Before diluting coal-tar-creosote or cresol dips with hard or alkaline water a test should be made to determine whether a separation occurs in such water. Pour one-half ounce of coal-tar-creosote or cresol dip into a 1-quart clear glass jar or bottle. While stirring thoroughly add enough water, preferably warm, to fill the container. Let the mixture stand for 1 hour. If an oily layer or mass of globules appear either at the top or the bottom of the liquid, the dip should not be used with that kind of water.

## Dips

Several kinds of dips are used to eradicate sheep ticks, as follows: Dilute rotenone dips prepared from derris or cube powder, the relatively new chlorinated hydrocarbon dips such as DDT, BHC, lindane, etc., nicotine, coal-tar creosote, fused bentonite-sulfur-cube, and arsenic-sulfur-rotenone dips. Some of

these are effective in one dipping, others usually require two applications and are included because they are well known. Some proprietary dips, on account of their rotenone content, are usually dependable in one dipping.

## Rotenone Dips

Experiments conducted by the Bureau of Animal Industry with derris and cube powders (finely ground roots of tropical plants widely used as insecticides) have shown that these materials are remarkably cheap and efficient for the control of sheep ticks with one dipping. The derris or cube powder should contain approximately 5-percent of rotenone, the principal active ingredient of the powders.

In preparing rotenone dips, 8 ounces of derris or cube powder are mixed with each 100 gallons of water (approximately 4 to 5 pounds of powder per 1,000 gallons). Nothing else need be added. The dry powder is not put directly into the vat, but first a thin paste is made by stirring all of the powder vigorously with about 5 gallons of cold water in a tub or barrel. This thin paste is then poured over the surface of the water in the filled vat, and the entire vat contents thoroughly stirred. Neither derris nor cube powder is soluble in water, but they form suspensions which impart a slightly muddy appearance to the water. Fine particles of the powder may settle to the bottom after a few minutes' standing. Stir the mixture well before use.

No field test is available for determining the rotenone content or actual potency of derris and cube dips. Large-scale experiments, nevertheless, have proved that even after a thousand sheep have passed through a vat, and have carried in large quantities of mud, the effectiveness of the dip was not noticeably impaired.

The length of time dilute derris and cube mixtures remain fully effective has not been determined. It is advisable to refill the vat with a fresh mixture after 4 to 5 days, or when the water becomes extremely filthy. To replenish the contents of the vat when the mixture is still relatively fresh and clean, add water and derris or cube powder at the rate of 8 ounces per 100 gallons. The powder should be mixed, as described, in a tub or barrel, with a small quantity of water. Water of varying degrees of hardness may be used with this insecticide.

Dilute derris and cube dips are harmless and odorless, do not soil or mat the wool, and permit lambs and ewes to "mother-up" promptly after they have been dipped. A single dipping is usually effective in eradicating the sheep tick, provided all animals in the flock are properly dipped. The sheep should be held in the swim for at least 1 minute, and the head submerged for an instant, at least once. The adult ticks are killed within 24 hours after dipping, and all ticks hatching thereafter from pupal cases attached to the wool usually die.

## Chlorinated Hydrocarbon Dips

The chlorinated hydrocarbon insecticides used as dips for the destruction of sheep ticks are DDT, methoxychlor, TDE, toxaphene, chlordane, BHC, and lindane. They are manufactured as wettable powders and emulsifiable concentrates. The wettable powders contain the dried insecticidal agent mixed with inert diluents such as kaolin, talc, and pyrophyllite, to which have been added wetting and dispersing agents. The emulsifiable concentrates are prepared by dissolving the insecticides in oils readily emulsifiable with water. They also contain wetting and dispersing agents. Both the wettable

powders and the emulsifiable concentrates can be added to the water in the vat without the mixing, cooking, or heating that is required with many of the older insecticides.

The chlorinated hydrocarbon insecticides have certain definite advantages over the older dips. They possess a greater degree of insecticidal efficiency, and if properly used, a single treatment will destroy all the motile ticks. All of them, and particularly BHC and lindane, are known to remain sufficiently potent in the wool to destroy the ticks hatching from the pupae after treatment. In addition, they are safe to use, and do not harm the wool. They must, however, be used properly and with care. The quantities of insecticide as well as the water must be measured accurately. If used too strong, they are dangerous to sheep and other livestock.

The wettable powder form of these insecticides is more satisfactory for ranch and farm use. They are safer to use and more compatible with the various types of water available for use in dipping vats throughout the country.

## DDT

Experimental and field trials indicate that dips containing 0.25 percent of DDT can be relied upon to eradicate sheep ticks in one dipping. Because technical DDT powder is not soluble in water and cannot be mixed satisfactorily with it, specially prepared forms of the chemical must be used in making up dips. Wettable DDT powders (for example, 50-percent wettable DDT) and DDT emulsifiable concentrates, both of which are commercially available, are especially suitable for the preparation of dips.

### Methoxychlor

Methoxychlor is available in the same formulations as DDT. It is used in the same concentration but is somewhat less effective.

## TDE

This insecticide closely resembles DDT. Use it in the same concentration as recommended for DDT.

### Toxaphene

The recommended concentration of toxaphene for the destruction of sheep ticks is 0.25 percent. Toxaphene is more effective against the sheep tick than DDT. It is obtainable both as a wettable powder and as an emulsifiable concentrate.

### Chlordane

Less information is available on the effectiveness of chlordane than toxaphene. Tests have proved that its effectiveness is near that of toxaphene. It is also obtained as a wettable powder and as an emulsifiable concentrate. It should be used in the same concentration as toxaphene.

DDT, methoxychlor, TDE, toxaphene, and chlordane are recommended for the destruction of the sheep tick in a concentration of 0.25 percent. To make a dip of this concentration from products of stronger concentration, use the following amounts with 100 gallons of water:

| | |
|---|---|
| Wettable powders: | |
| 25-percent | 8 pounds |
| 40-percent | 5 pounds |
| 50-percent | 4 pounds |
| Emulsifiable concentrates: | |
| 50-percent | 2 quarts |
| 65-percent | 1½ quarts |

### Benzene Hexachloride (BHC)

The insecticidal component in benzene hexachloride (BHC) is the gamma isomer. A 0.025-percent gamma isomer concentration is recommended for the eradication of sheep ticks with a single treatment.

Wettable BHC powder can be obtained having a gamma isomer concentration of 6, 10, or 12 percent. To make a dip having a gamma isomer concentration of 0.025 percent consult the following tabulation which gives the quantities of powder of different percentages of concentration to be used for each 100 gallons of water to fill the vat.

| BHC wettable powder: | |
|---|---|
| 6-percent | 3½ pounds |
| 10-percent | 2 pounds |
| 12-percent | 1¾ pounds |

### Lindane

Lindane is the pure gamma isomer of BHC. For the destruction of sheep ticks lindane should be used in the same concentration as BHC, namely 0.025 percent. It can be obtained commercially as wettable powder and as an emulsifiable concentrate. In preparing a dip to kill sheep ticks, use the following quantities per 100 gallons of water:

| Wettable powder: | |
|---|---|
| 25-percent | 13 ounces |
| Emulsifiable concentrates: | |
| 20-percent | 1 pint |
| 25-percent | 0.8 pint |

***Caution.*** **Both rotenone and DDT are poisonous to fish. In emptying vats, therefore, take care to prevent the material from flowing into fishing streams or ponds. In disposing of used dips do not allow pools to form from which animals may drink, or let the dips drain upon vegetation on which livestock are permitted to graze.**

### Nicotine Dips

Nicotine or tobacco dip is sold under various trade names, and flock owners are more or less familiar with its use in dipping for scabies. In 0.07-percent solution, this insecticide will eradicate sheep ticks if the sheep are dipped twice with an interval of 24 to 28 days between dippings. Any brand of nicotine or tobacco dip approved by the Bureau of Animal Industry for use in official dipping of sheep for scabies is suitable for use in eradicating sheep ticks. These dips should be used in accordance with the instructions on the container and they should not be heated to above 105° F.

### Coal-Tar Creosote Dips

Coal-tar creosote dips are sold under many trade names. They are made from coal-tar derivatives and the principal ingredient is creosote oil, which is made soluble in or miscible with water by means of soap. When diluted with soft water, they are efficacious in eradicating sheep ticks if the flock is dipped twice with an interval of 24 to 28 days between dippings. There is no field test for determining the deterioration of these dips, and consequently in replenishing the dip the percentage of active principle in the vat is largely a matter of guesswork. For this reason, coal-tar creosote dips should be used to dip small farm flocks, small enough so they can all be dipped without having to replenish the vat contents.

Most coal-tar creosote dips sold commercially contain 50 percent of cresylic acid. Instructions for their use are usually printed on the manufacturer's label. The instructions should be followed carefully. In no case should the dilute dip contain more than 0.4 percent or less than 0.1 percent cresylic acid.

The naphthalene and other constituents of undiluted coal-tar creosote dips tend to separate, especially in cold weather. Stir the dip well, therefore, to see that it is homogenous in character before using any portion of it. It should not be mixed with water having a high alkali content. The minerals in hard water combine with substances in the dip making it injurious to sheep.

### Cresol Dips

Cresol dips are sold under various trade names, and consist of a mixture of cresylic acid with soap. The term cresylic acid as used in this connection covers those cresols and other phenols derived from coal tar, none of which boil below 185° C. (365° F.) nor above 250° C. (482° F.) When diluted ready for use cresol dip should contain 0.5 percent of cresylic acid. As there is no field test available for cresol dips, the rate of deterioration cannot be determined at the vat, and consequently after a few sheep have been dipped there is no method known for keeping constant the percentage of cresylic acid in the used dip.

When used with suitable water these dips are very efficacious in eradicating sheep ticks, if the flock is given two dippings 24 to 28 days apart.

### Fused Bentonite-Sulfur-Cube Dip

A commercial product known as fused bentonite-sulfur-cube is being used to some extent as a dip for sheep ticks. As the name implies, melted sulfur is absorbed into bentonite clay; the mass is reduced to a granular form, and mixed with cube powder. When added to water in the vat according to the manufacturer's instructions on the container, the resultant mixture is milky-white and some of the sulfur in it is said to be in colloidal form. When sheep emerge from the vat, the wool is temporarily matted and the fleece dries slowly. It is not safe, therefore, to dip sheep in fused bentonite-sulfur-cube dip when the weather is very cold or stormy. It is a safe dip, however, when the weather is warm. One dipping will usually eradicate sheep ticks.

### Arsenic-Sulfur-Rotenone Dip

A proprietary product known as arsenic-sulfur-rotenone has been widely used by sheepmen. The product is said to contain some rotenone and other derris extractives, and arsenic, combined with specially prepared sulfur. Since the product contains arsenic, a known poisonous substance, due precautions should be observed in using it.

## Injury From Dipping

Dipping often results in a slight setback to sheep. They may suffer a temporary shrinkage in weight or constitutional disturbances or both. These conditions may occur with any of the standard dips, but various other factors should be considered before placing the blame on the dip—the age and physical condition of the sheep, the method of handling at the vat as well as before and after dipping, the character of the water used, and the method of preparing the dip.

Young animals in a thriving condition recuperate rapidly from any temporary ill effects, while old, weak, or emaciated animals regain lost weight slowly. Also, serious losses may follow the dipping of sheep that are in an extremely poor physical condition. These sheep should not be dipped, especially in benzene hexachloride (BHC) or lindane. Dipping should be delayed until the general physical condition of the sheep has been greatly improved. Injury is more likely to result from improper methods of dipping and handling than from the direct effects of the dip. Rough handling of sheep in the corrals and catch pens; dipping immediately after a long, hard drive before they have rested and cooled off; dipping late in the afternoon when the nights are cold; keeping them without feed and

water for long periods before and after dipping; using dogs in the corral; and fighting stubborn sheep to get them into the chutes, are some of the contributing causes of injury. However, some of the dips if used in unsuitable water may cause injury, and any of them used too strong are injurious to sheep.

The question often arises as to the proper age at which lambs should be dipped to get the best results and cause the least damage. It is perfectly safe to dip the flock when the lambs are not less than 1 month old, provided the lambs are dipped separately. Any slight shrinkage caused at this time will be regained quickly and the lambs will grow and thrive much more rapidly after being freed of the irritation caused by ticks. If the work is done properly and the sheep handled carefully, pregnant ewes may be dipped with safety at any time up to within 1 month of lambing.

## Dipping Plants

The farmer who has a small flock to dip can use a portable galvanized-iron vat as shown in figure 7, turning a part of his barnyard or sheds into catch pens for temporary use. The portable galvanized-iron dipping vats, called "hog vats," can be purchased ready-made and will answer the purpose very well for dipping small lots of farm sheep. They are sometimes set on the surface of the ground and the sheep lifted into them, but this method is not very satisfactory. An excavation should be made, the dimensions of which slightly exceed the outside dimensions of the vat, except the depth, which should be less, so that when the vat is set in the trench the top may extend about 6 inches above the surface of the ground. Approaches and draining and holding pens may be provided as desired.

A permanent sheep-dipping plant is desirable equipment in the sheep business. Such a plant should be so constructed that, if necessary, it can be used in dipping sheep for scab as well as for ticks and other parasites. The plan for a dipping plant shown in figure 8 includes cooking and settling tanks for lime-sulfur dip. Information on other types of dipping vats and on special problems will be furnished by the Bureau of Animal Industry on request.

### Selecting a Location

In selecting a location for a dipping plant consider the fact that sheep work better upgrade. If possible, the ground used for the receiving corrals and chute should slope up to the end of the vat which should be on level ground. The vat should preferably extend north and south, with the entrance at the south and the exit at the north, as sheep work better when not facing the sun. Good natural drainage is a point to consider in selecting a location.

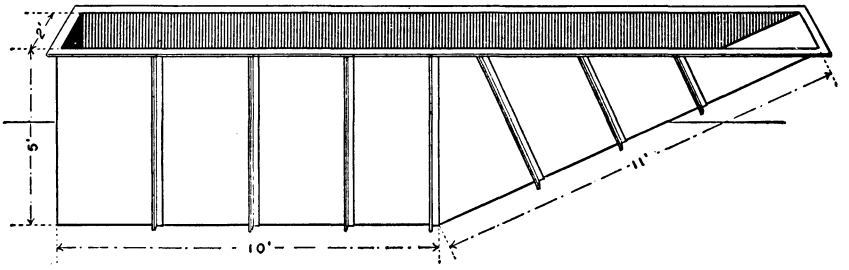



Figure 7.—Portable galvanized-iron sheep dipping vat.

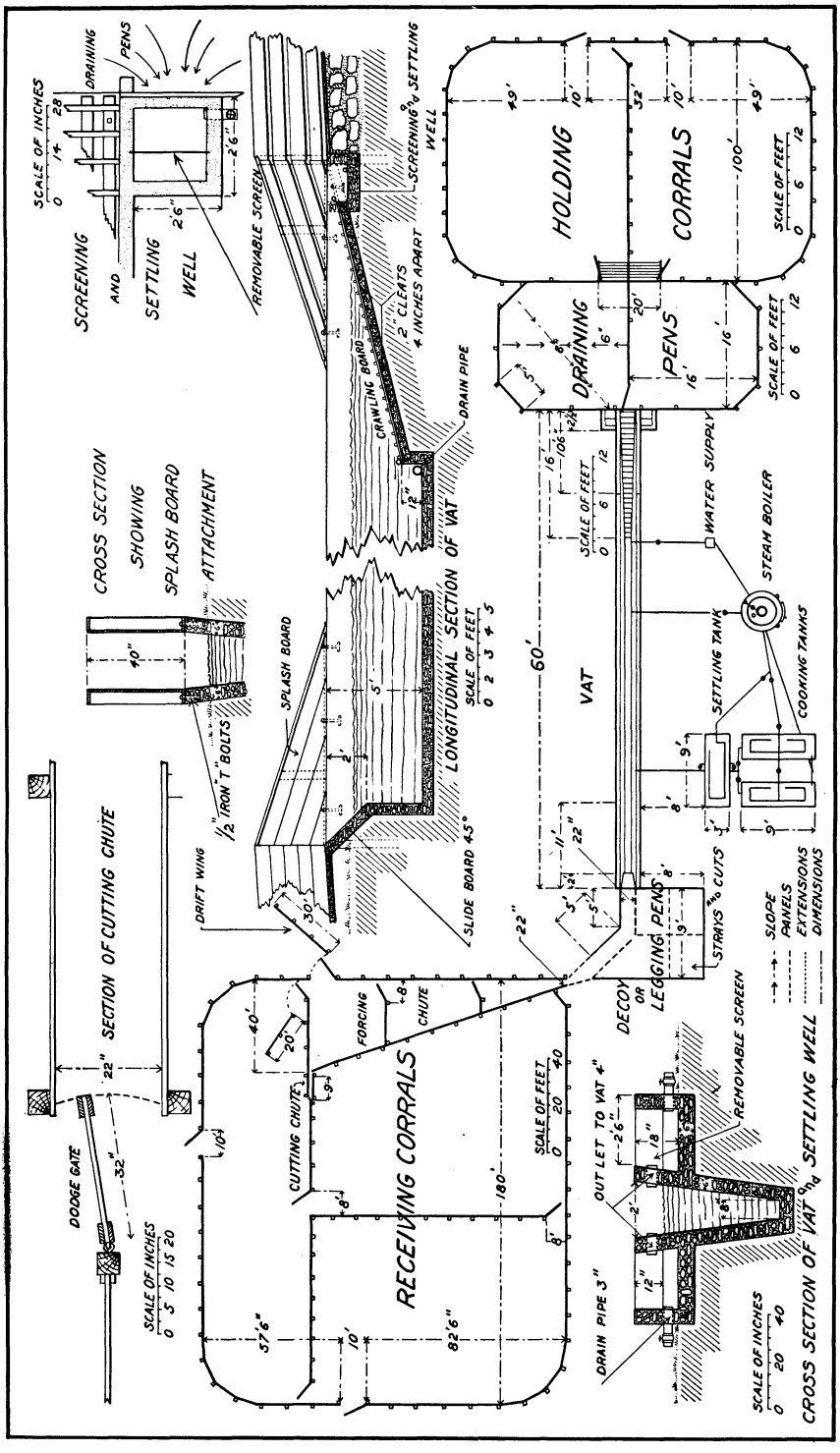



Figure 8.—Plan of sheep-dipping plant; concrete vat.

## Corrals and Chutes

The arrangement of the corrals in a dipping plant is important. The receiving corrals, as well as the holding corrals, into which the animals go from the draining pens, should be large enough to hold a full band of sheep, or about 3,000 head. The receiving corral should be constructed with the least practicable number of corners or places in which the sheep may become jammed or piled up.

In an effort to get out of the corral, a sheep will try to go back to the place where it entered; therefore, if the entrance gate is near the vat the herd will tend to crowd toward the vat and thus save considerable work in getting them into the chute or catch pen. The corrals and chutes may be so arranged that a combination catch pen and running chute is provided. Sheep usually work well in a chute the first time they are dipped, but old ewes that have been dipped several times in the same vat often have to be put into the vat by hand.

The location and arrangement of the chutes are sometimes changed from year to year so the sheep may not recognize them so readily. The running chute should be curved to obstruct the view, and the side on which the men work should be tightly boarded. The usual height for the sides of the chute is 40 inches, the width, about 22 inches, depending on the size of the sheep. The chutes and alleys should be upgrade to the vat. A small pen should be provided near the entrance to the vat and so arranged that the sheep can see it. This pen, known as a "decoy pen," is filled with sheep to induce the others to join them in the pen. The size and arrangement of the corrals will vary necessarily with the topography of the location and the individual ideas of the owner.

## Draining Pens

When a sheep emerges from a vat it carries out a large quantity of dip in its fleece. Most of the dip drains out very rapidly. Save this dip and return it to the vat by providing draining pens with watertight floors sloping toward the vat. The size of the pens will depend upon the size of the plant and the number of sheep to be dipped. The relative size shown in the plan illustrated in figure 8 may be followed, increasing or decreasing it to correspond to the length of the vat. There should be two draining pens, each having an opening into the holding corral. They may be made of lumber or concrete and should have catch basins or screening and settling wells into which the dip drains so as to prevent manure and foreign matter from being carried into the vat. Drawings of screenings and settling wells will be found in figure 8. In constructing draining pens of concrete, build the outer walls 6 inches thick in the same manner as the foundation for a house. Fill the space inside the walls with gravel to the required height and lay the floor on it. Roughen the surface of the concrete floor with a stiff broom, or apply a coat of "pebble dash" to provide a suitable surface for the sheep to stand on. Downgrade the floors so that the dip will drain away rapidly and not collect in pools from which the animals may drink.

## Vats

The dipping vat may be of either lumber or concrete, but concrete is preferable. The length of the vat may vary from 30 to 100 feet, depending on the number of sheep to be dipped. Public dipping vats, where 50,000 to 100,000 sheep are dipped each season, should be 100 feet long. The depth should be 5 feet, the width at the bottom 8

inches and at the top 2 feet. There should be no crosspieces to interfere with the movement of the sheep or of the men working along the vat. The top of the vat is usually flush with the ground. As a matter of individual taste, however, the top may extend from 9 to 18 inches above the ground. Vats extending above the ground afford a better opportunity to handle the sheep and can be operated with less effort than those having the top flush with the ground. If the top of the vat is to be flush with the ground, build it at least 4 inches above the natural surface of the ground and then fill in with dirt or gravel to obtain proper drainage along the sides.

Whenever possible, the gravity method of draining off the old dip should be adopted. Otherwise it will be necessary to pump or dip it out each time the vat is cleaned. The end of the vat having the drain should be slightly lower than the other end so that all the liquid will drain off.

The slide board into the vat should be set at an angle of 45° and extended from the floor of the chute to at least 4 inches below the dip line. It should be made of, or covered with, a smooth-surfaced material such as planed lumber or sheet metal. The end extending into the dip should be flush with the vertical end of the vat. A space between the slide board and the end of the vat, if large enough for a lamb to lodge in, is a dangerous arrangement. The runway leading out of the vat should not be too steep. The length should vary from 8 to 16 feet, the latter being preferable in large vats.

## Concrete Vat

In the plan for the concrete plant (fig. 8) the corrals and chute are conveniently arranged. The portable panels can be shifted to form either a running chute or a catch pen. The settling and screening wells shown can be constructed as a part of any vat by changing the slope of the draining pens so the dip will run into the wells instead of down the runway. In making the forms for a draining well, grooves should be provided for the removable screen as well as the 4-inch openings for drain and outlet pipes.

The trench for a concrete vat should be excavated so that the inside dimensions correspond to the outside dimensions of the vat. If the sides of the trench are smooth and reasonably firm they can be used as the outer wall of the form, but in all cases where the vat is extended above the surface of the ground it is necessary to build forms extending from the surface of the ground to the top of the vat. If the soil is sandy it will be necessary to build outer forms, in which case the trench should be wide enough to allow for these forms. The drain and other pipes shown in the drawing should be placed in the form and should all be threaded and capped so that proper connections may be made. The ½-inch iron bolts and the iron pipe shown in the drawings should be embedded in the concrete of the incline for attaching the false floor or crawling board. The floor is made of 1- by 6-inch boards laid lengthwise with cross cleats as shown in drawings. The splashboards at the entrance end of the vat and the guides at the exit end are nailed to 2- by 4-inch scantling bolted to the concrete wall. The bolts should be embedded when the wall is being constructed. Two pairs of bolts should also be embedded for attaching the slide board. Steam pipes should not be molded into the concrete walls, as the vibration of the pipes will crack the wall. They should pass over the top of the vat and down the side in a groove formed in the wall, so they will not come in contact with the sheep or

cause annoyance to the men working along the vat.

The walls should be 6 inches thick, constructed of concrete mixed in the proportion of 1 part cement, 2½ parts sand, and 4 parts broken stone or gravel. Place the mixture in the forms as soon as the mixing is finished. To make a dense, watertight wall, the concrete should be well settled into place by thorough tamping and spading. Leave the forms in place about 3 days, wetting the concrete daily. After the forms are removed, dampen the surface of the concrete and apply a finishing coat composed of 1 part cement and 2 parts screened sand, or mix cement and water to the consistency of cream and apply it with a brush, forming a smooth surface.

### Wooden Vat[2]

Two styles of framing are used in constructing a wooden vat. Cedar-post frames are preferable because they do not decay as rapidly as pine lumber. When hardwood is used the frame timbers need not be so heavy; 4 by 4 inches is heavy enough for framing in hardwood. The frames are set from 2½ to 4 feet apart, depending on the character of the soil and the material used. The closer the frames are to each other the less tendency there is for the sides of the vat to bulge between the frames. Two-inch tongue-and-groove lumber should be used and beveled so all joints and seams may be properly calked with oakum or similar material.

If the open-tank heating system is used, settling wells are unnecessary, because the heating tank acts as a settling well. The open tank heating system has one advantage over the coil-heating system in that the pipes are easily cleaned if they become clogged.

When dipping operations are completed for the day, place an improvised water stop gate at the exit end of the vat to prevent rain from flowing into the vat. It should be high enough to divert the flow to the outside of the draining pen.

As an added safeguard, measure the depth of the dip at the end of the day's operation. The next morning the approximate amount of additional water that may have entered the vat during the night can be calculated. This is very important, especially when using a dip for which there is no vat-side test. However, where an accepted vat-side test is available, any dilution of the dip can readily be determined.

## Care of Plant When Not in Use

A dipping plant that does not receive proper care when not in use deteriorates very rapidly. The pressure of the ground against the sides of the vat causes the walls to bulge inward. This tendency may be counteracted to some extent by keeping the vat full of liquid. Wooden vats allowed to stand empty will dry out, the lumber will shrink causing the vat to leak when refilled. At the close of dipping operations, leave the vat full of liquid and add water from time to time to restore that lost by evaporation.

A week or 10 days prior to beginning dipping operations the entire plant should be overhauled and put in good condition. Before charging a new vat or one that has stood empty for some time, fill it with water to see whether it leaks.

## Construction of Dipping Plants

A plan for construction of a concrete sheep-dipping plant is shown in figure 8. It is not drawn to a

[2] A plan for construction of a wooden vat is shown in Farmer's Bulletin 713, Sheep Scab.

uniform scale; consequently, in studying the drawing, note the scale of each part. The plant shown has no superfluous equipment, and the arrangement is as simple as is consistent with efficiency. The size can be increased or decreased as desired. A corral, chute, and catch pen arrangement is shown, and cross fences can be added to the corral as desired. Cutting chutes are shown in the plan, as every large dipping plant should have such a chute equipped with a dodge gate so lambs may be cut out and dipped separately.

If permanent pipes are used for conducting water and dip to the vat they should not be an obstacle to the men working along either side of the vat. The pipes can be placed under the ground, or a portable V-shaped trough can be used for conducting liquids into the vat and laid aside when not in use.

## Treatment By Spraying

Spraying as a method of treatment for the destruction of sheep ticks has not been as thoroughly tested as dipping. Research on this method is still in progress and the recommendations made for the use of insecticides as sprays are tentative until further information is obtained as to the effectiveness of the insecticides, their formulations and means of application.

Use all but rotenone sprays at twice the strength recommended for dips. Sheep should be sprayed for ticks shortly after shearing. The short wool at this time exposes the ticks and the spray will be more effective than when the wool is long. After shearing, the ticks will migrate from the ewes to the lambs, and successful flock treatment depends to a great extent upon careful and thorough treatment of the lambs.

Low pressure sprayers operating at pressures from 100 to 200 pounds per square inch are satisfactory for small farm flocks when in short wool. But for range flocks and those having long thick wool, machines developing 200 to 400 pounds' pressure per square inch are more satisfactory.

## Spraying in Pens

Pen spraying requires a holding pen having a connecting runway to a spraying pen which is strong enough and large enough to hold from 25 to 50 head of sheep, allowing them room for movement. It can be any convenient corral or enclosure or can be set up by means of portable panels. The portable panel pen is in some ways superior to a permanent pen, especially for the treatment of range sheep. It can be set up easily and conveniently to suit the work conditions. It can be moved readily from one location to another. When the ground becomes so wet from the spray that it is difficult to handle the sheep, the panels can be moved to dry ground. Portable panels can be arranged in a rough circle to avoid corners and recesses into which sheep might crowd and pile up.

The holding pen can be any enclosure. On the range it is usually made with sheep wire netting held up with steel driven poles. A runway made of panels is set up connecting the holding pen to the spraying pen.

Sheep will turn away from the spray and pile up in bunches if there are any corners or other recesses. They must be kept moving or only a part of the body will be sprayed. If two spray operators work together in the pen the sheep can be kept moving at all times and can be caught in a cross-fire attack from both sides. Particular attention should be paid to wetting the underside, because the ticks concentrate on the under surface of the neck, chest, and to a lesser extent

the belly. All parts of the body should be thoroughly wet. This requires from 4 to 6 quarts per animal.

The spray tank should be equipped with an agitator to keep the spray uniformly mixed. The sprayer should have two hoses, also two guns of any type containing number 4 to 7 disk with the whirl plate removed. A desirable piece of equipment is an attachable extension to the spray gun barrel for spraying the underside of the sheep. This extension should have three nozzles at a 45-degree angle, and it can be made from a ¾-inch pipe about 3 feet long.

## Spraying in Chutes

Sheep at times are sprayed in a chute. This is done by attaching to the hose a length of pipe bearing a series of nozzles. The pipe is bent into a rectangle or a circle fitted to conform to the width of the chute. This device is known as a boom. The number of nozzles on a boom varies from 8 to 16. The nozzles are so arranged that the stream is directed toward the animal from all angles. The boom is attached to the sides of the chute usually near the middle of its length. Some operators prefer to attach it near the chute exit. A quick release valve, operated either by hand or foot, is installed near the hose and boom connection. As the sheep are driven through the chute and go through the boom, the spray is turned on from above, below, and the sides simultaneously.

Field experience has shown that boom spraying is not nearly so effective as pen spraying. This is largely because, as the animal approaches the boom, it will hesitate; when forced onward it will jump through the boom and be exposed to the spray for only a moment. The momentary exposure results in inadequate wetting and poor penetration of the fleece.

## Insecticides for Spraying

The sheep tick is easily killed and most of the recognized commercial insecticides give reliable results.

### Rotenone

Rotenone sprays are prepared in the same manner and in the same proportions as rotenone dips (see p. 11). Adding one-half pound of one of the common household detergents to each 100 gallons of spray will facilitate mixing, and will cause the spray to penetrate the wool more completely. Until recently it was believed necessary to add sulfur to rotenone sprays and dips. Comparative tests made with cube or derris powder alone and combined with sulfur have proved that the effectiveness of this insecticide is not increased by the addition of sulfur.

### Chlorinated Hydrocarbons

The chlorinated hydrocarbon insecticides, such as DDT, methoxychlor, TDE, BHC, lindane, toxaphene, and chlordane, used in dips (see p. 11) for eradicating sheep ticks, are also effective in sprays. However, in sprays, an 0.5-percent concentration is recommended for DDT, methoxychlor, TDE, toxaphene, and chlordane. They are usually purchased as 40- or 50-percent wettable powders, and a concentration of 0.5 percent is obtained by adding 8 pounds of powder to each 100 gallons of water for the 50-percent product and 10 pounds per 100 gallons for the 40-percent product.

Lindane is usually prepared as a wettable powder containing 25 percent of lindane and 75 percent of inert material and wetting agents. Benzene hexachloride (BHC) is usually obtained as a wettable powder container 6, 10, or 12 percent gamma isomer. In spraying, the

recommended concentration to destroy sheep ticks with lindane and BHC is 0.06 percent gamma isomer. To make a spray with lindane having a gamma isomer concentration of 0.06 percent, add 2 pounds of powder to each 100 gallons of water. To make a spray with BHC having a gamma isomer concentration of 0.06 percent add 8 pounds of the 6-percent powder to each 100 gallons of water. For the 10-percent powder add 5 pounds, and for the 12-percent powder add 4 pounds per each 100 gallons of water.

### Caution in Spraying

All these insecticides should be used with caution. When preparing spray mixtures, the quantities of water should be accurately measured and the insecticide carefully weighed. Irresponsible methods will result in losses in livestock and injury to those treating them. Unused spray should not be poured into streams, because these insecticides are harmful to fish. Quantities of unused spray should not be permitted to collect in pools on the ground where livestock can drink from them. Extreme care should be taken to prevent water, feed, and forage from being contaminated with any of these insecticides. These chlorinated hydrocarbon insecticides should not be used with water at temperatures in excess of about 80° F.

## Treatment By Dusting

Research with dusts for the control of sheep ticks is still in progress. Recommendations for treatment with dusts cannot be made until more data have been collected as to its effectiveness. Standard formulations have not been established, and the equipment in use is of an experimental nature.

The machines used are usually 4- to 6-horsepower engines equipped with dust hoppers from which the insecticide is withdrawn and forced through a series of hoses, which lead to a frame placed at the end of a chute. The sheep are driven through the frame fitted to the chute, and the hose outlets in the frame are so placed that the sheep are dusted from above, below and the sides as they go through the frame. The dust output is maintained by a stop-cock on the dust hopper at about 4 pounds per minute, when the engine is developing 2,500 RPM.

The insecticides usually used are cube powder, containing 5 percent of rotenone, and DDT powder, containing 5 percent of DDT. The insecticides must be mixed with carrying agents or diluents such as pyrophyllite powder, wettable sulfur, or bentonite sulfur. The addition of a small quantity of number 10 motor oil has been found to increase the effectiveness of the dusts. Successful treatments have been reported with a mixture of 1 part of cube (containing 5-percent rotenone), 10 parts of pyrophyllite, and 2 parts of number 10 motor oil. These powders may cause irritation to the eyes and throats of persons using them; wearing a dust mask is advised.

U. S. GOVERNMENT PRINTING OFFICE: 1953

For sale by the Superintendent of Documents, U. S. Government Printing Office
Washington 25, D. C. — Price 10 cents